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Radiant Heating and Cooling Made Easy and Inexpensive

The Problem

Conventional hydronic radiant floor (HRF) heating systems offer significant comfort and efficiency benefits to homeowners, but they carry high installation and component costs. Also, homes with HRF heating usually require a forced-air system at an additional cost. Combine these issues with homebuilder concerns about puncturing the radiant tubing during home construction, and it's easy to understand why HRF systems are relegated to the high-end, custom-home market.

The Solution

The Rapid Radiant Deployment System (RRDS) developed by Davis Energy Group reduces the costs of HRF systems by standardizing and simplifying the installation process and by using the radiant system to provide cooling and heating—in many cases, this system *completely eliminates the cost of a forced-air system*.

Features and Benefits

The RRDS combines tools, procedures, and components into a heating and cooling system that production builders can use to create comfortable, energy-efficient homes that save occupants money from the day they move in.

Improved comfort. Radiant heating systems are well known for the superior comfort they provide. In a survey conducted for this project, 97 percent of occupants of homes using radiant heating systems indicated that radiant heating is more comfortable than forced-air heating.

Simplified installation with reduced risk of leaks. The Davis Energy Group identified procedures and tools that simplify and speed up the process of attaching radiant tubing to the steel mesh that reinforces the concrete slab (**Figure 1**). The RRDS also ensures that the hydronic tubing is held at a consistent depth within the concrete slab, well out of reach of the explosive charge-driven fasteners that are used to attach interior wall plates to the floor. This procedure also substantially reduces the risk of puncture and leakage.

Positive cash flow for homeowner. Davis Energy Group modeled the costs and benefits of the RRDS in a 1,600-square-foot (ft²) one-story home and a 2,600 ft² two-story home in six California climate zones. Based on the RRDS's current incremental costs,

Figure 1: Installing radiant tubing using the RRDS

The Rapid Radiant Deployment System (RRDS) simplifies and speeds the process of attaching radiant tubing to the steel mesh used to reinforce the slab, which speeds installation of the tubing in the field.



heating energy savings of 15 to 30 percent, and cooling energy savings of 50 to 80 percent will create positive cash flow for the single-story home in all six climate zones (**Table 1**, page 2). The analysis also indicates positive cash flow for two-story homes in five of those climate zones. Davis Energy Group expects the RRDS to cost less than conventional HVAC equipment once it has achieved significant production volume and market share.

High-efficiency space and water heating. The RRDS uses an instantaneous gas-fired water heater with an energy factor of 0.82 to provide hot water for space heating and for domestic use. This performance compares favorably to a conventional furnace with an annual fuel utilization efficiency (AFUE) of 78 percent. (These two efficiency values are comparable because the instantaneous water heater has no standby losses.) The system's efficiency also exceeds that of conventional gas water heaters, which have energy factors ranging from 0.5 to 0.7.

High-efficiency ductless cooling. The RRDS uses a ductless, high-efficiency, two-stage evaporative cooler to provide cool air directly to the home during the day. Chilled water is circulated through the radiant system at night, which pre-cools the slab and substantially reduces daytime cooling loads. Analysis indicates that in cooling mode, the system will operate at an effective energy-efficiency ratio (EER) exceeding 40, compared with an EER of about 15 for the best available compressor-based equipment.

Table 1: Projected annual savings

When its incremental costs are included in a 30-year mortgage, the RRDS provides a positive cash flow in most California climates. In extremely hot climates, such as El Centro, additional cooling is required on peak days.

Location	Annual savings (\$/y)			
	Current market		Mature market ^a	
	One-story	Two-story	One-story	Two-story
Santa Rosa	130	21	266	270
El Toro	69	-47	205	202
Riverside	205	88	341	337
Sacramento	184	76	320	325
Fresno	351	240	487	489
El Centro	1,022 ^b	952 ^b	1,158 ^b	1,324 ^b

Notes: y = year.

- In a mature market, a negative incremental installed cost is projected for the RRDS chiefly due to elimination of forced-air components and consolidation of heating and water heating systems.
- Cooling setpoint may be exceeded.

Applications

The RRDS can replace conventional HVAC equipment in new residential construction, particularly in production homes. Modeling by the Davis Energy Group indicates that the RRDS can satisfy all heating and cooling loads in five of the six California climate zones that it investigated. The only exception is that these systems may not be able to accommodate peak cooling requirements in extremely hot climates, such as California's Climate Zone 15. Otherwise, RRDS is applicable in any region where evaporative cooling is viable and for heating-only applications in all climate zones. The RRDS could also be installed in multifamily and commercial construction where concrete slab floors are often poured on multiple levels.

California Codes and Standards

The RRDS will make it easier for homebuilders to meet Title 24 home efficiency requirements. The absence of ductwork eliminates leaks of conditioned air into unconditioned spaces as well as losses resulting from ductwork routed through unconditioned spaces.

What's Next

The RRDS will be used in four prototype homes in a large subdivision being built in Borrego Springs, California. If the system is successful in these homes, it may be used in all homes built in the subdivision. Davis Energy Group also plans to work with component suppliers to develop a prepackaged hardware center that would minimize on-site plumbing time and facilitate meeting the "mature market" cost targets used in the economic analyses.

Collaborators

Davis Energy Group and IPEX Inc. collaborated on this project.

For More Information

Reports documenting this project and providing more details may be downloaded from the web at www.davisenergy.com/swhdt.

To view Technical Briefs on other topics, visit www.esource.com/public/products/cec_form.asp.

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About PIER

This project was conducted by the California Energy Commission's Public Interest Energy Research (PIER) program. PIER supports public-interest energy research and development that helps improve the quality of life in California by bringing environmentally safe, affordable, and reliable energy services and products to the marketplace.

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